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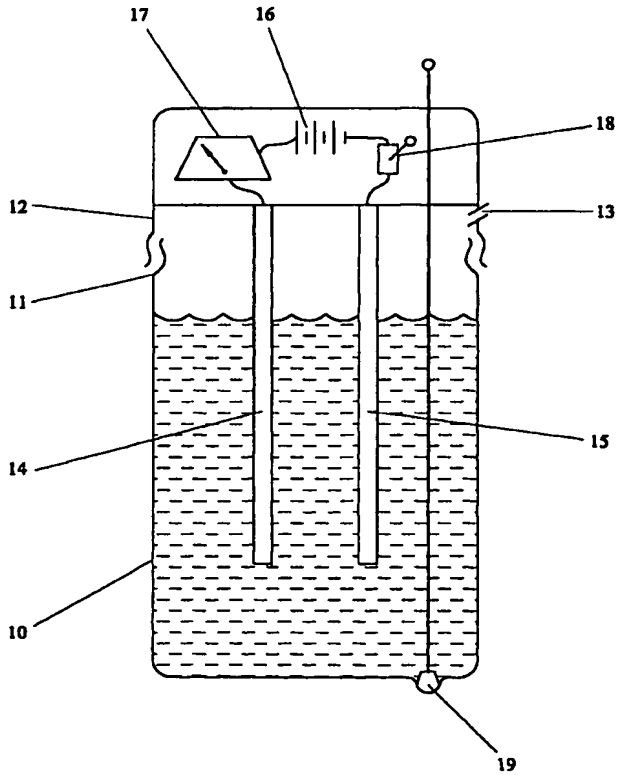
(54) Title: APPARATUS AND METHOD FOR THE PRODUCTION OF DISINFECTANT

(57) Abstract

Apparatus for the production of disinfectant comprises a portable, vented vessel (10) to contain a chloride solution, a pair of electrodes (14, 15) extending into or adapted to extend into the vessel, portable means (16) for generating a direct electric current and applying the current to the electrodes, means (17) for monitoring that current, and a second vessel, or a defined larger volume of the vented vessel, for contacting the hypochlorite solution produced in the portable vessel with water.



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APPARATUS AND METHOD FOR THE PRODUCTION OF DISINFECTANT

The present invention is concerned with the production of a disinfectant comprising a hypochlorite solution. The invention comprises an apparatus and a method for that purpose.

There are many circumstances in which it may be desired to disinfect contaminated water and in many situations it is desired or necessary to carry out the disinfection on a relatively small scale. For example, water for drinking or washing or other hygienic purposes may be required on a domestic or similar local scale. One of the most widely used disinfectant procedures is chlorination, the reactive form of chlorine being added to water either as chlorine gas or, more usually, as hypochlorite. However these reactive components are unstable and may be difficult to obtain in isolated locations, for example in many rural areas of the developing world or in remote areas of the developed world.

Against this background, it is an object of the present invention to provide apparatus for the production and use of a hypochlorite solution, which apparatus is particularly suitable for use in a range of situations and on a relatively small scale, for example in an isolated location.

The apparatus according to the present invention comprises a portable, vented vessel to contain a chloride solution, a pair of electrodes extending into or adapted to extend into the vessel, portable means for generating a direct electric current and applying the current to the electrodes, means for monitoring that current, and a second vessel, or a defined larger volume of said vented vessel, for contacting the hypochlorite solution produced in said portable vessel with water to be disinfected therewith.

The apparatus of the present invention makes possible the production of a relatively limited quantity of hypochlorite solution, and to use it to produce a supply of treated water, at sites where there is otherwise no satisfactory supply of hypochlorite, using raw materials that are more stable and more readily available, for example rock salt or sea salt. Thus it may be used wherever there is a requirement for a chlorine-based disinfectant.

For example, the apparatus may be used to produce drinking water, for example for travellers, campers, walkers and others without access to treated water, including people in developing countries or in war zones and for refugees. The apparatus may also be used for the production of a disinfectant solution for cleaning purposes or for treating babies' feeding bottles before use, or for producing disinfectant for medical purposes, for example in field hospitals and war zones, in refugee camps and in any location where there is no conventional supply of chlorine or of hypochlorite.

The apparatus is also suitable for producing drinking water for animals, to prevent the spread of water-borne diseases such as Salmonella and Campylobacter.

The chloride solution which is introduced into the vessel is most preferably a solution of sodium chloride, although if circumstances make it necessary or convenient or otherwise desirable a solution of another chloride salt, for example of potassium chloride, could be used. The chloride may be in the form of unpurified rock salt or sea salt. As an alternative, the chloride solution may be in the form of sea water or brine. The apparatus is operated for sufficient time to produce the desired amount of reactive chlorine, principally in the form of hypochlorite, and the latter is then added to the appropriate amount of water for the intended purpose, that is to produce water of satisfactory quality for drinking or to produce a more

concentrated disinfectant solution for cleaning or hygiene purposes.

In one form of the apparatus according to the present invention, the specified components are housed within a single unit. As one alternative, the main components are in the form of separate modules, which are electrically inter-linked as required to form the functioning electrical circuit.

In operation of the apparatus according to the invention, a concentrated solution of chloride, for example a 1 per cent by weight solution of sodium chloride, is subjected to electrolysis to produce nascent chlorine at the anode and this nascent chlorine reacts rapidly with water to form the desired hypochlorite. The quantity of hypochlorite produced is determined by the concentration of the original salt solution and by the size of the applied current and the length of time for which it is applied.

The hypochlorite solution thus produced is subsequently introduced into the second vessel, or into the defined larger volume of the main vented vessel, in order for the solution to treat a larger volume of water or other liquid than is contained within the main vessel. By way of example, the first vessel, in which the hypochlorite solution is first generated, may fit within, or on top of, the separate second vessel. As one alternative, the apparatus may be in the form of a single unit in which the two vessels are distinct component parts, the first vessel being a component of smaller volume than the second vessel. A further possibility is for the main vented vessel to be divided, by markings on its surface, into a smaller volume in which the hypochlorite is generated and a larger volume for using the hypochlorite for water treatment.

The capacity of the portable, vented vessel in which the hypochlorite is produced may typically be relatively small, for example of the order of 0.02 to 5.0 litres, preferably up to

2.0 litres. However the capacity of the second vessel, or defined larger zone of the first vessel, may be considerably greater than this. For example, when the apparatus is to be used to produce treated water, for example drinking water, the second vessel or larger zone may have a capacity of up to or exceeding 500 litres; when the purpose is to produce hypochlorite solution for cleaning or hygiene purposes, its capacity may typically be of the order of 1 to 10 litres.

The electrodes by which the direct electric current is introduced into the salt solution within the portable generating vessel may be of various materials. For example, they may both be of the graphite form of carbon or, in another form, the anode may be of graphite carbon and the cathode of stainless steel. Other possible materials of which one or both of the electrodes may be formed are other metals, for example copper or silver, platinum, titanium or rare earth metals. The electrodes may be rod-shaped or in the form of flat plates, or another shape to conform to the contours of the portable vessel.

As specified, the electrodes extend into, or are adapted to extend into, the portable generating vessel. In one preferred form of the invention, the electrodes may extend into the vessel from the inner face of a lid upon which they are mounted. In a first alternative form, the electrodes may be mounted to extend inwardly from a wall or walls of the vessel itself. In yet another form of the invention, the vessel itself may be one of the electrodes. For example, the anode may be formed of a graphite layer on the inner face of the vessel, with the cathode being in the form of a stainless steel electrode extending into the vessel from the lid, or the mounting of these two electrodes may be reversed.

As indicated, the portable vessel is vented to permit the release of gases such as hydrogen and/or oxygen generated electrolytically during the electrolysis of the vessel

contents, in order to avoid any safety hazard arising from their presence in the vessel.

The apparatus also includes portable means for generating a direct electric current and applying the current so generated to the electrodes. That means may take several alternative forms. For example, the current-generating means may be a dry-cell battery, which may be designed to be rechargeable and/or replaceable. As one alternative, the current-generating means may be a photovoltaic system, permitting the device to be driven by solar power; such a system may include a rechargeable battery, to enable the device to be operated during periods of darkness.

As another possibility, the means for generating the required direct current may be in the form of a mechanical generator, for example driven manually. Such a current source, for example of a dynamo type in which the armature is rotated manually, has the important advantage of requiring no other source of electrical energy; such a system may also include a rechargeable battery, to enable the power generated by the dynamo to be stored until required for the generation of hypochlorite.

In yet another form of the invention, the means for generating a direct electric current may comprise two or more of the foregoing forms, for example a chemical battery and/or a photovoltaic system and/or a mechanical generator, within the same apparatus, thereby allowing the user of the apparatus to select the current-generating means most appropriate for the situation and/or circumstances in which the apparatus is to be used. The apparatus may, for example, have a modular construction, where the vessel and electrodes form one separate module, which is then connected to a second module comprising the source of the current by an electrical cable of suitable length. In this way, a single vessel can be powered using different plug-in sources (for example, a battery or a solar

cell or a mechanical generator) depending upon circumstances and availability, providing greater flexibility than if the power source and vessel are produced as a single unit.

The apparatus according to the present invention is of particular benefit when used in a fixed set of circumstances, for example to treat a fixed volume of water with a given amount of hypochlorite. The quantity of hypochlorite required to be generated is determined by the quantity of water to be treated in the second vessel and by the final concentration of hypochlorite required in the water after treatment. By way of example, if the water after treatment is to be used for drinking, then the final concentration of hypochlorite in that water may lie in the range from 0.1 to 1.0 parts per million; if the water is to be used for cleaning and/or hygiene purposes, then the concentration of hypochlorite may lie in the range from 20 to 500 parts per million. In some cases, it will be possible to achieve the desired hypochlorite concentration in the water in the generating vessel, after operating the device for a short period of time, without needing to dilute the solution into the second vessel.

The concentration of hypochlorite produced is determined by the amount of salt added to the portable generating vessel, the size of the current applied and the time for which it is applied. Where the current applied to the electrodes is of a variable value, then the apparatus may include an ammeter indicating the size of the current generated, preferably in milliamps or amps. The current is applied for a particular length of time, for example from a few minutes to in excess of an hour or more. As one alternative, the current and salt concentration may be of fixed values and only the length of time need then be monitored, allowing the amount of hypochlorite generated to be calculated from the total quantity of electricity passed through the salt solution within the portable generating vessel, which is determined as the product

of the level of the direct current and the time for which it is applied.

In one embodiment of the apparatus according to the present invention, it includes an automatic timer switch, for example a clockwork switch, by which the current supply may be switched off after a given period of time. That time may be of a predetermined fixed value or may be selected by the operator to reflect the amount or concentration of the hypochlorite required to be generated.

In another form of the apparatus according to the invention, it may include components that allow it to operate until a fixed amount of charge has passed between the electrodes and, once this fixed amount of charge has passed, the current will be automatically switched off, so that the operator is aware that the fixed amount of charge has now passed between the electrodes. Since the amount of hypochlorite generated is a direct function of the amount of charge passing between the two electrodes, this will provide the means of obtaining a pre-determined amount of hypochlorite, irrespective of the current supplied to the device. In another alternative form, the apparatus may include a component or components to show the total amount of charge that has passed between the electrodes; this component would, in essence, be operating as a "coulomb meter", displaying the amount of charge in the form of a dial or meter and the operator would then select the appropriate reading to correspond to a particular amount of hypochlorite produced by the device. The advantage of either of these two alternatives is that the device may then be powered by a range of sources, of different voltage or current, but the operator would be able to produce a particular amount of disinfectant irrespective of the power source, making it more versatile and ensuring the reliable production of a particular amount of disinfectant. These two alternatives also have the advantage of producing a specified amount of disinfectant from a variable

power source, for example a photovoltaic power source used in intermittent cloud.

The invention will now be further described with reference to the accompanying drawing, which illustrates, by way of example only, one preferred embodiment of the apparatus according to the present invention, in elevation and partly in section.

The illustrated embodiment of the invention comprises a generally cylindrical vessel 10 of plastics material, threaded at 11 to receive a removable, screw-on lid 12, which is vented at 13 to allow escape from the vessel 10 of gases produced during the electrolytic process. Extending into the vessel from the lid 12 are two electrodes 14, 15, which in the illustrated example are both of graphite. A battery or alternative source of direct current 16, linked to the electrode 14 via an ammeter 17 and to the electrode 15 via a switch 18, is housed within the lid 12.

In use of the device, a known amount of salt is added to the vessel and the vessel is then filled, for example up to a marker line or one of a series of marker lines corresponding to a given volume of liquid, with the water to be used for the generation of hypochlorite solution. The capacity, or maximum capacity, of the vessel 10 may for example be in the range 0.02 to 5.0 litres, depending upon the volume of water to be treated.

The switch 18 is operated to provide a direct current supply to the electrodes 14, 15, the value of the direct current being displayed on the ammeter scale 17. A typical value for that current might be within the range from 20 to 1000 milliamps, depending upon the source of current.

The amount of hypochlorite required to be generated is determined by the volume of the second vessel and the hypochlorite concentration required in the second vessel.

Since the amount of hypochlorite produced is a direct function of the quantity of electric charge, that is of the size of the current and the length of time for which it is applied, it is a straightforward matter of operating the device for the required time at the current level displayed on the ammeter 17.

In one variant form of the illustrated embodiment of the present invention, the ammeter 17 is replaced by a component which measures the total charge that has passed between the two electrodes, which component is referred to herein as a "coulomb meter". Using a coulomb meter, the apparatus may then be operated for such a time as elapses until a fixed amount of electrical charge, for example from 25 to 250 coulombs, has been passed between the electrodes.

In a simplified further variant form of the present invention, a standardised volume of salt solution of fixed concentration, for example in the range 1% to 30% sodium chloride by weight, is treated in the portable generating vessel by using a fixed current applied for a fixed time, in which case the device may include a timer switch to turn off the current supply after the fixed time. If the current supply is of a known and stable value, the ammeter or coulomb meter 17 may then be omitted.

When the required hypochlorite solution has been duly generated, it is transferred into water within the second vessel (not shown) for immediate use; the need to store the unstable solution is thus avoided. This transfer may simply be made by pouring the generated solution from the illustrated first vessel into the second vessel. As one alternative, the portable vessel 10 may be provided, as illustrated, with a valve or plug 19 in its base, whereby the solution may be transferred directly into the second vessel located immediately below the vessel 10. As a further alternative, the portable vessel may be completely immersed, with its generated contents, into water within the second vessel, to enable the two solutions to mix.

As already described, the two vessels may alternatively take the form of the two distinct volumes within a single vessel and the generated hypochlorite solution may then be transferred into the larger treatment zone by tilting of the vessel.

The invention is further illustrated by means of the following Example.

Example

A volume of 0.5 litre of water containing 10% by weight of sodium chloride was subjected in the illustrated apparatus to electrolysis at 100 milliamps for 30 minutes, the battery 16 being a standard 9-volt PP3-type battery. The resulting solution was transferred to a second vessel containing 50 litres of water contaminated with the faecal bacterium Escherichia coli (E.coli) at over 1 million colony-forming units per litre. After transfer, samples of the water in the second vessel were examined (based on standard plate counts on nutrient agar, a non-selective medium) and the E.coli bacterium was not detectable after 10 minutes. The residual chlorine in the water in the second vessel was at a level greater than 0.2 milligrams/litre, which is in accordance with standard international norms and World Health Organisation guidelines for drinking water, indicating that the device is fully able to produce water of potable quality.

CLAIMS

1. Apparatus for the production of a disinfectant, which apparatus comprises a portable, vented vessel to contain a chloride solution, a pair of electrodes extending into or adapted to extend into the vessel, portable means for generating a direct electric current and applying the current to the electrodes, means for monitoring that current, and a second vessel, or a defined larger volume of said vented vessel, for contacting the hypochlorite solution produced in said portable vessel with water to be disinfected therewith.

2. Apparatus as claimed in Claim 1, wherein all said components are housed within a single unit.

3. Apparatus as claimed in either of the foregoing claims, wherein said vented vessel is adapted to fit within, or on top of, said second vessel.

4. Apparatus as claimed in Claim 2, wherein said two vessels are distinct component parts of a single unit, said first vessel being a component of smaller volume than said second vessel.

5. Apparatus as claimed in Claim 2, wherein said vented vessel is divided, by markings on its surface, into a smaller volume in which the hypochlorite is generated and a larger volume in which the generated hypochlorite is contacted with water to be disinfected.

6. Apparatus as claimed in any of the preceding claims, wherein the capacity of the portable, vented vessel lies within the range from 0.02 to 5.0 litres.

7. Apparatus as claimed in any of the preceding claims, wherein the capacity of said second vessel, or of said larger

volume of said vented vessel, lies within the range from 1 to 500 litres.

8. Apparatus as claimed in Claim 7, wherein said capacity of said second vessel, or of said larger volume of said vented vessel, lies within the range from 1 to 10 litres.

9. Apparatus as claimed in any of the preceding claims, wherein said electrodes extend into the vessel from the inner face of a lid upon which they are mounted.

10. Apparatus as claimed in any of claims 1 to 8, wherein said electrodes extend into the vessel from a wall or walls of said vessel.

11. Apparatus as claimed in any of Claims 1 to 8, wherein said vessel itself forms one of the electrodes.

12. Apparatus as claimed in any of the preceding claims, wherein said current-generating means comprises a dry-cell battery or a photovoltaic system or a mechanical generator, or a combination of two or more of said current-generating means.

13. Apparatus as claimed in any of the preceding claims, including further an automatic timer switch, whereby to switch off the current supply after a predetermined time.

14. Apparatus as claimed in any of Claims 1 to 12, including further means to remove said current supply after a predetermined charge has passed.

15. Apparatus as claimed in any of Claims 1 to 12, including further means to show the total amount of charge that has passed between the electrodes.

16. Apparatus for the production of a disinfectant, said apparatus being substantially as hereinbefore described with reference to, and as illustrated in, the accompanying drawing.

17. A method for the production of a disinfectant, which method comprises introducing a chloride solution into the portable vented vessel of the apparatus as claimed in any of the preceding claims and withdrawing a disinfectant solution of hypochlorite from said second vessel or from said defined larger volume of said vented vessel.

18. A method for the production of drinking water, which method comprises introducing a chloride solution into the portable vented vessel of the apparatus as claimed in any of Claims 1 to 16, and transferring the hypochlorite solution so generated into a larger volume of water in said second vessel.

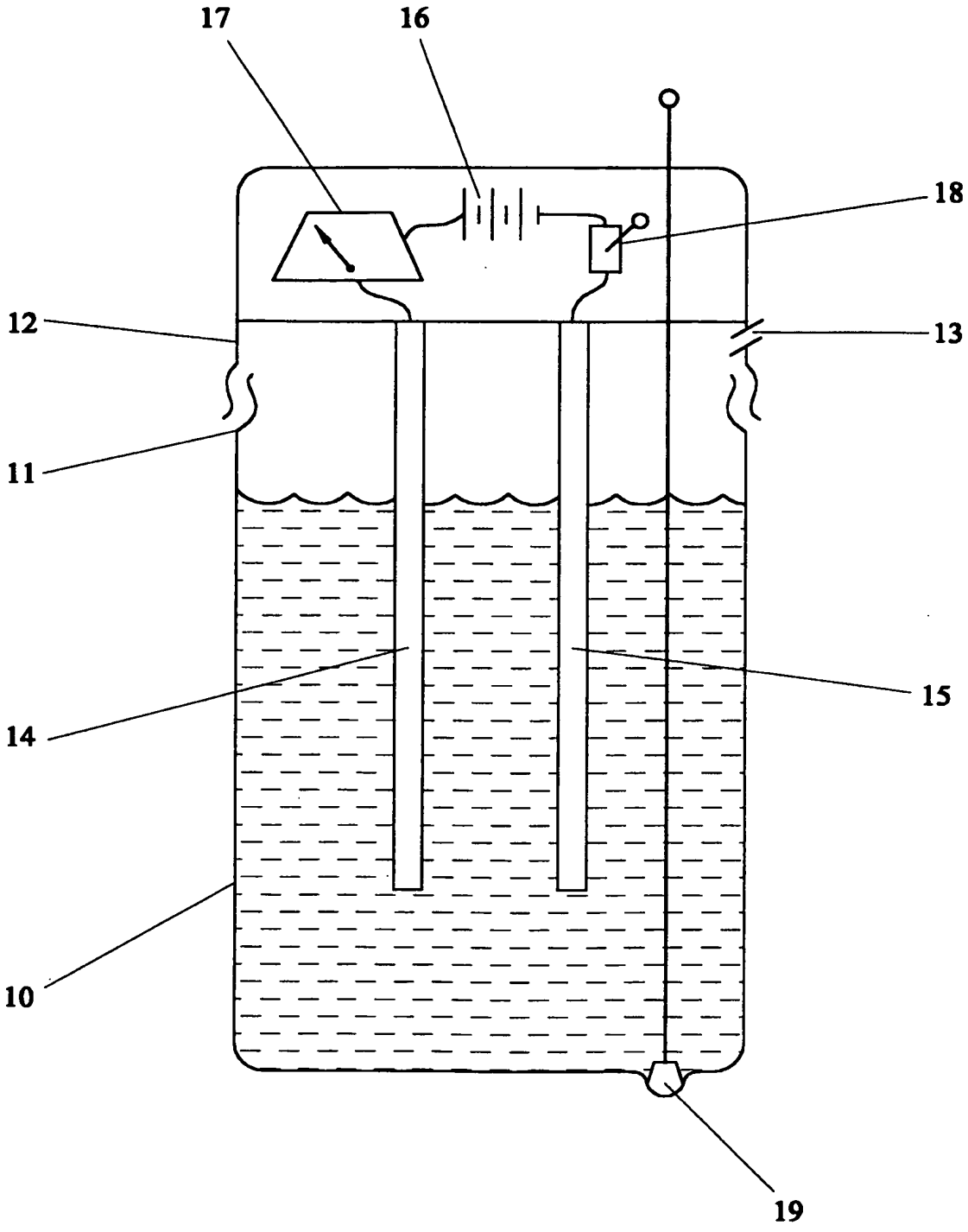

FIG. 1

INTERNATIONAL SEARCH REPORT

Internal Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 C02F1/46 C02F1/76

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 C02F C25B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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